Electronic Services - Los Angeles
M11500X

INSTRUCTION BOOK
MODEL 56 A
DC NULL DETECTOR
SER# 195 AND ABOVE

A-3 272
METROLOGY

BOONTON ELECTRONICS CORPORATION

MP MASTER
MA24698

INSTRUCTION BOOK
MODEL 56 A

DC NULL DETECTOR

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METROLOGY
LABORATORY

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SECTION I

MODEL 56A

SPECIFICATIONS

Voltage Range:	1.0 microvolt to 100 volts dc.
Current Range:	10^{-13} to 10^{-5} ampere dc.
Input Capacitance:*	22 μμf .01 to 100 range without cable 46 μμf 1K to 100 K range without cable 150 μμf .01 to 100 range with cable 175 μμf 1K to 100K range with cable
Input Resistance:	10 megohms all ranges.
Sensitivity Ranges:	8 calibrated in amplifier gain .01,.1, 1.0, 10, 100, 10K and 100K.
Full Scale Sensitivities:	(SENS. ADJ. at max.)
Voltage:	10 microvolts to 100 volts dc.
Current:	1 micro-microampere to 10 micro-amperes.
Power:	10^{-17} watt to 10^{-3} watt.
Sensitivity per Division on Most Sensitive (100K) Range:	
Voltage:	.5 microvolt.
Current:	.05 micro-microampere.
Noise Level:	Less than 1 μv PP
Zero Drift:	Less than 2 microvolts after warm-up.
Response Time:	Approximately 1 second full scale.
Modes of Operation:	
Hunt:	Provides 60 DB meter scale compression.
Calibrate:	Provides linear indication with resolution to .5 microvolt.

* Input capacitance measured with 100 KC test frequency.

SECTION I

MODEL 56A

SPECIFICATIONS (cont'd)

Mode Switching:	Front panel or by remote switch.
Meter:	1.2 - 0 - 1.2 scale.
Meter Linearity:	2% maximum error.
Amplifier Gain:	Continuously variable from -60 db to +100 db.

Output Characteristics

Output:	± 1.0 ma into 1000 Ω; ± 2 ma into 100 Ω or less. Polarity the same as input.
Impedance:	Approximately 400Ω
Ripple:	Less than .01v RMS

Overload Tolerance:

Range	Approximate Full Scale Voltage	Overload Voltage Tolerated	Overload Factor
.01	100V	1000V	10
.1	10V	1000V	100
1	1V	1000V	1K
10	.1V	1000V	10K
100	.01V	100V	10K
1K	1 mv	10V	10K
10K	.1 mv	10V	100K
100K	.01 mv	10V	1M

Power Requirements: 105 to 125V, 50-60 cycles, 40 watts; or 210 to 250 volt, 50-60 cycles.

Size:	Portable	7-1/4 W x 9-1/2 D x 11 H excluding handle.
	Rack	19 W x 10-1/4 D x 7 H with handle
Weight:		12 lb. net.

SECTION II

GENERAL DESCRIPTION

The Model 56A DC Null Detector is a sensitive, high impedance device designed for use with dc bridges or for other applications where sensitivities are required that are considerably greater than available from the best mechanical galvanometers.

The 8 step "Sensitivity" switch allows inputs decading from 10 microvolts to 100 volts to give full scale deflection on the zero center meter. The meter is calibrated on each side of zero in divisions of .05 for a "full scale" of 1.0 with an over-calibration of 20%. A sensitivity control used in conjunction with the range switch permits relating a desired percentage tolerance to the limits marked in red at 1.0 on the meter scale. A switch allows the selection of either a compressed or linear amplifier mode of operation. In the compressed (HUNT) mode of operation, 60 db of meter scale compression virtually eliminates the need to switch ranges when hunting for a balance with an unknown component. In the linear (CAL) mode the meter scale is linear over a -1.2 to +1.2 range. The HUNT-CAL switch may be operated at the front panel or remotely by cable connection to a side receptacle.

The input circuit may be operated either grounded or floating. The instrument case and panel are connected through the power line cable to ground. Terminal 1 of the input receptacle is connected to the amplifier chassis which is insulated from the instrument case by approximately 500 megohms. The amplifier chassis may be grounded by connecting the shorting link between the Ground and Floating Chassis terminal posts located on the front panel.

The Model 56AR DC Null Detector is identical to the Model 56A electrically. Physically, the components have been rearranged to mount on a 7" x 19" standard rack panel, and the Output Bias Adj. (R53) has been moved to the front panel for accessibility.

TABLE 1-1 Equipment Supplied:

No. per Equipment	Name of Unit	Overall Dimensions H	W	D
1	Model 56A DC Null Detector	12-1/4	7-1/8	9-3/8
1	Input Cable Assembly	4 ft. approximately		
1	Plug (Jones P-302-CCT) for HUNT/CAL switch receptacle.			
1	Instruction Book.			

TABLE 1-2 Electron Tube Complement:

No. per Equipment.	Tube Designation	Type	Function
1	V5	6X4	Rectifier
1	V6	OA2	Voltage Regulator
1	V1	12AX7	Amplifier
1	V2	6AU7	Amplifier
2	V3, V4	12AT7	Amplifiers

TABLE 1-3 Fuse Complement:

Fuse Rating. AGC 0.5 ampere

TABLE 1-4 Chopper Complement:

Mechanical Chopper	BEC 540,108
Transistor Chopper	2N34

SECTION III

OPERATING PROCEDURE

3.1 General

3.1.1 This section describes in detail the operating procedure for the Model 56A Null Detector. All information required for safe and proper operation of the instrument is included. Be sure to read this section before placing the instrument into operation.

3.2 Initial Inspection

3.2.1 After unpacking the unit, and before plugging it into an ac outlet for the first time, turn the instrument back and forth several times to make sure the tubes have not fallen from their sockets due to rough handling.

3.2.2 Observe the meter pointer to see that it moves freely and rests at zero when the instrument is steady.

3.2.3 If the pointer rests to the right or left of zero, set it at zero with the zero set screw.

3.3 Turn-On Procedure.

3.3.1 Verify that the power source and power rating plate agree or that a suitable converter is used.

3.3.2 Plug the instrument into the power source.

3.3.3 Connect input cable assembly to the instrument at jack marked INPUT.

3.3.4 Set the toggle switch to ON (up), and allow a warm-up period of approximately 10 minutes.

3.3.5 Short the black and red clips of the input cable.

3.3.5.1 With the SENSITIVITY selector switch (S1) on 100K, the SENS. ADJ. (R35) at Max., and HUNT-CAL switch (S2) on CAL, set the meter electrically to zero using the control marked ZERO (R45). Then as the SENSITIVITY selector switch is moved to each position the meter should remain at zero.

3.3.6 In an instrument capable of indicating an input signal as small as a fraction of a microvolt, several sources of unwanted meter indications are of importance. Two of the most common of these are hum pickup and thermal voltages. The 56A includes a 60 ∿ rejection filter which reduces hum pickup effects by more than 60 db. Ideally the 56A and bridge should not be placed in the presence of a strong ac field. If this cannot be avoided the instruments, and in particular the bridge output and 56A input terminals should be carefully shielded. Thermal voltages are the result of a temperature change at the junction of dissimilar metals. In the input circuit of the 56A, considerable care has been taken through the choice of materials and placement of parts to minimize thermal voltages. Similar care must be taken with the circuit to which the input cable of the 56A is connected. (The insulated alligator clips provided with the 56A are made of beryllium copper. When attached to the phone tip prods of the input cable and shorted to each other the resultant thermal voltage is negligible.) A zero offset when connected to the external circuit

may be the result of thermal voltages; however, in some instances it is difficult to differentiate between thermal and ac field effects. In general, if a cause and effect relationship can be observed between a temperature change in the external circuit and a null indicator movement, then it can be assumed that thermal voltages are present. For greatest accuracy at high sensitivity these thermal voltages must be eliminated either through the choice of proper materials in the circuit or the maintenance of a constant temperature in the external circuit environment. Other effects that may produce unwanted deflections of the null indicator are:

3.3.6.1 Galvanic action (battery effects)

3.3.6.2 Photosensitivity (particularly of semi-conductor devices)

3.3.6.3 Amplifier noise (caused usually by noisy tubes, resistors, or capacitors in the input stage.)

3.4 Procedure for Using with a Wheatstone Bridge

3.4.1 Connect the 56A input leads to the bridge output observing proper polarity. Disconnect bridge's internal galvanometer. The black input lead is to be connected to the ground or shielded terminal of the bridge. In some instances it will be desirable to remove the insulated alligator clips in order to use the phone tips as connecting devices. The alligator clips are removed by unscrewing from the insulated prods.

3.4.2 Connect the unknown resistor to the bridge and select an appropriate setting of the bridge ratio arms.

3.4.3 Check the null indicator for correct zero adjustment as in 3.3.5.1,then set SENSITIVITY switch to .01 range.

3.4.4 Apply the dc voltage (See Overload Tolerance in Specifications) to the bridge. It is conventional to use a battery polarity which will give null indicator deflection to the right (positive) when the resistor under test is higher in value than the bridge setting. Proceed with the normal bridge balancing procedure adjusting the decade resistors until the null indicator of the 56A reads zero. If no deflection of the null indicator occurs, turn the SENSITIVITY switch clockwise until a deflection occurs.

3.4.5 If the null indicator deflects a negligible amount with a one-step change in the setting of the lowest resistance decade of the bridge, the sensitivity of the 56A should be increased. Increase the setting of the SENSITIVITY switch until a position is found which will give satisfactory null indicator deflection. Observe the null indicator pointer for several moments to assure that thermal voltages, as evidenced by a slow drift in one direction, are not present. On the 100K SENSITIVITY position a moderately fast movement (jitter) of about 1/2 division is normal.

3.4.5.1 Avoid the use of excessive sensitivity. Difficulty in locating a balance and erratic operation can be the result of using too much sensitivity.

3.5 Procedure for use with a Limits or Unbalanced Wheatstone Bridge

3.5.1 Resistors can be selected to tolerances or matched very rapidly using this method.

3.5.1.1 Connect the 56A to the bridge as in 3.4.1.

3.5.1.2 Connect to the measuring posts of the bridge a nominal resistor from which percentage deviations are to be measured.

3.5.1.3 Balance the bridge as in 3.4.3 through 3.4.5 with the HUNT-CAL switch in CAL position.

3.5.1.4 Unbalance the bridge by that percentage of the nominal (as measured) resistance which is to be used as a limit for production test. This unbalance can be achieved either by adding appropriate series or shunt resistors to the standard resistor, or, most conveniently by adjusting the resistance decades of the bridge by an amount which is equal to the desired resistance limit.

3.5.1.5 Adjust the null indicator pointer of the 56A to the limit line (1.0) using the SENS. ADJ. control. Reset the bridge to the specified nominal resistance value. The null indicator scale of the 56A may now be used to observe a range of plus or minus the desired percentage tolerance with a 20% extended calibration at each end of the scale. When the standard resistor is replaced with production resistors to be tested the 56A will evaluate the test resistor as a decimal part of the tolerance without the necessity for any further bridge or equipment adjustments. An example would be, a batch of resistors is to be selected to 11085 Ω ± 0.5%.

3.5.1.5.1 Select a resistor at random and measure its resistance on the bridge. See paragraph 3.4.

3.5.1.5.2 Assume this measured resistor was 11128 ohms.

3.5.1.5.3 Change bridge setting to equal value of the measured resistor plus the tolerance:
11128 Ω + 55.64 Ω = 11183.64 Ω (Round off to 11183)

3.5.1.5.4 If conventional bridge battery polarization has been used, the null indicator has deflected to the left. With the SENS. ADJ. control adjust the null indicator to read -1.0. Do not disturb the SENS. ADJ. control after this adjustment.

3.5.1.5.5 Return the bridge setting to the nominal resistance value. Remove the randomly selected resistor from the bridge test posts. The bridge and 56A Null Detector are now set-up for fast production testing of resistors.

3.5.1.5.6 When a resistor is connected to the bridge test posts the null indicator of the 56A will show the direction in which it differs from the nominal and the amount in a decimal part of the tolerance. A null indicator reading of +.3 is interpreted:

.3 x .5% = .15%
11085 x (.15%) = 16.6 Ω above nominal
or 11085 + 16.6 = 11101.6 Ω.

3.6 Procedure for using HUNT mode of operation.

3.6.1 This is advantageous when "hunting" for the value of a resistor whose order of magnitude is unknow, or, when adjusting an "over-wound" resistor to a very close tolerance.

3.6.1.1 Connect the 56A and unknown resistor to the bridge as in 3.4.1 and 3.4.4.

3.6.1.2 With the HUNT-CAL switch in the HUNT position,

apply the dc to the bridge and observe the deflection of the null indicator of the 56A.

3.6.1.3 Adjust the bridge resistance decade in a direction to move the null indicator pointer toward zero. Note that for conditions of large unbalance, a large change in the resistance decade setting produces a relatively small movement of the null indicator pointer and that as balance is approached the null indicator becomes progressively more sensitive to changes in the resistance decade arm of the bridge.

3.6.1.4 For greatest accuracy of measurement the 56A should be returned to the CAL mode of operation after the bridge has been brought close to balance in the HUNT mode.

3.6.1.5 The bridge and 56A may be set up for limits operation, then switched to HUNT mode for rough adjustment or "hunting", with a return to CAL mode for final precise measurement or adjustment.

3.6.1.6 A receptacle (J2) at the right side of the 56A permits an external switch to be used. This receptacle is wired in parallel with the HUNT/CAL switch (S2). When the panel HUNT/CAL switch is in the CAL position, closing the receptacle circuit, (as with an external foot switch) places the 56A in the HUNT mode of operation. In some cases a foot switch selection of HUNT/CAL is desirable because it frees both hands of the operator for making adjustments on the resistor under test

3.7 Amplifier Output.

3.7.1 The dc output of the Model 56A is available at terminal posts on the front panel. This output may be used to operate a dc recorder or to trip limit determining relays in an automatic test set-up. An output bias control (OUTPUT BIAS ADJ. R 53) on the right side of the case allows the output level to be adjusted to a desired reference level on the recorder.

SECTION IV

THEORY OF OPERATION

4.1 General

4.1.1 A simplified block diagram is shown in Figure 2. The circuit consists of an input range switch; a filter to reduce the effect of the external hum pick-up; a chopper which converts the dc to ac of the power line frequency; a four stage negative feedback amplifier; a transistorized synchronous rectifier that reconverts the amplified ac to dc; a zero-center dc microammeter indicator; a cathode follower output amplifier; and a power supply.

4.2 Range Switch

4.2.1 The input dc voltage is applied to an 8 position selector switch, which, on the three most sensitive ranges effects its control by varying the amount of feedback in the amplifier. On the five lower ranges of sensitivity the input voltage is divided to maintain a constant attenuator output of 1 millivolt to apply to the low pass filter. The input circuit has the "ground" conductor carried on the connector contacts to minimize ground loops and series resistance problems which can occur when ground is carried by the connector shell. The shielded input cable is terminated in insulated phone tips with detachable insulated alligator clips. These clips are made of beryllium copper to reduce the thermocouple effects which result from connecting the conventional steel clips to brass or copper conductors. The input system is arranged so that the input resistance remains essentially constant at 10 megohms on all ranges.

4.3 Low Pass Filter.

4.3.1 The range switch output is applied to a multi-section low pass filter which will attenuate unwanted 60 ∿ pick-up by at least 60 db. Frequencies above a few cycles are attenuated by the filter. This restricts the use of the 56A to dc or very low frequency ac applications. Because the amplifier has been designed for a very high 60∿ gain (for amplifying the low level 60∿ output of the chopper), the rejection of unwanted 60∿ voltages at the input becomes a necessity.

4.4 Converter Chopper.

4.4.1 The dc at the filter output is applied to a low-noise mechanical chopper where it is converted to an ac voltage of the same frequency as the ac power source. The chopper-amplifier combination is insensitive to variations in line frequency over a range of approximately 50 to 60 cycles. A bias voltage applied to one side of the chopper serves as the meter zero adjustment.

4.5 Amplifier.

4.5.1 The chopper output is capacitively coupled to a two stage low-noise, non-microphonic dual triode amplifier. The third stage is a high gain pentode which couples into a medium gain amplifier stage consisting of half of a dual triode. The remaining half of the dual triode operates as a cathode follower with the SENS. ADJ. control in its grid circuit. Ths stages of the amplifier are resistance-capacitance coupled. These coupling networks and associated filters have been designed to peak

in the 50 to 60~ region with pronounced fall-off in gain below and above this band. This band-pass characteristic adds to the attenuation effect of the low pass input filter in minimizing the error caused by the pick-up of unwanted high or low frequency voltages. A portion of the output is applied out-of-phase to the first and third stages. The amount of this feed-back is selected by the range switch to give the required over-all gain on each of the three most sensitive ranges.

4.6 Synchronous Rectifier.

4.6.1 The output of the final ac amplifier, a cathode follower, is applied to a transistor rectifier. The driving voltage for the transistor is phased so that the polarity of the rectified voltage is the same as the polarity of the voltage at the input of the DC Null Detector. The polarity and amplitude of the rectifier output are indicated on the 6 inch zero-center meter.

4.7 Power Supply.

4.7.1 The power supply circuits provide: regulated 150 volts for the plates of the tubes in the first four stages of the amplifier; 190 volts unregulated for fifth amplifier stage and the cathode followers; a low voltage dc for the filaments of the first three stages of the amplifier. The remaining filaments are operated from 6.3 volt ac from the power transformer. A -14 volt bias voltage is also supplied for meter zeroing, and the output cathode followers.

4.8 Cathode Follower.

4.8.1 The pulsating dc voltage from the transistor rectifier is applied to the grid of one triode of a balanced cathode follower. The Output Bias Adj. control (R53) is in the grid circuit of the other or balancing triode. The adjustment range of the Output Bias Adj. control (with no voltage at the input) is from a small negative current to more than +1 ma in a 1000 Ω load. Output filtering is accomplished by a smoothing filter in the grid circuit of the signal cathode follower, which is also capacitively coupled to the grid of the balancing cathode follower. The polarity and magnitude of the dc output is proportional to the dc input when front panel switch is in CAL position.

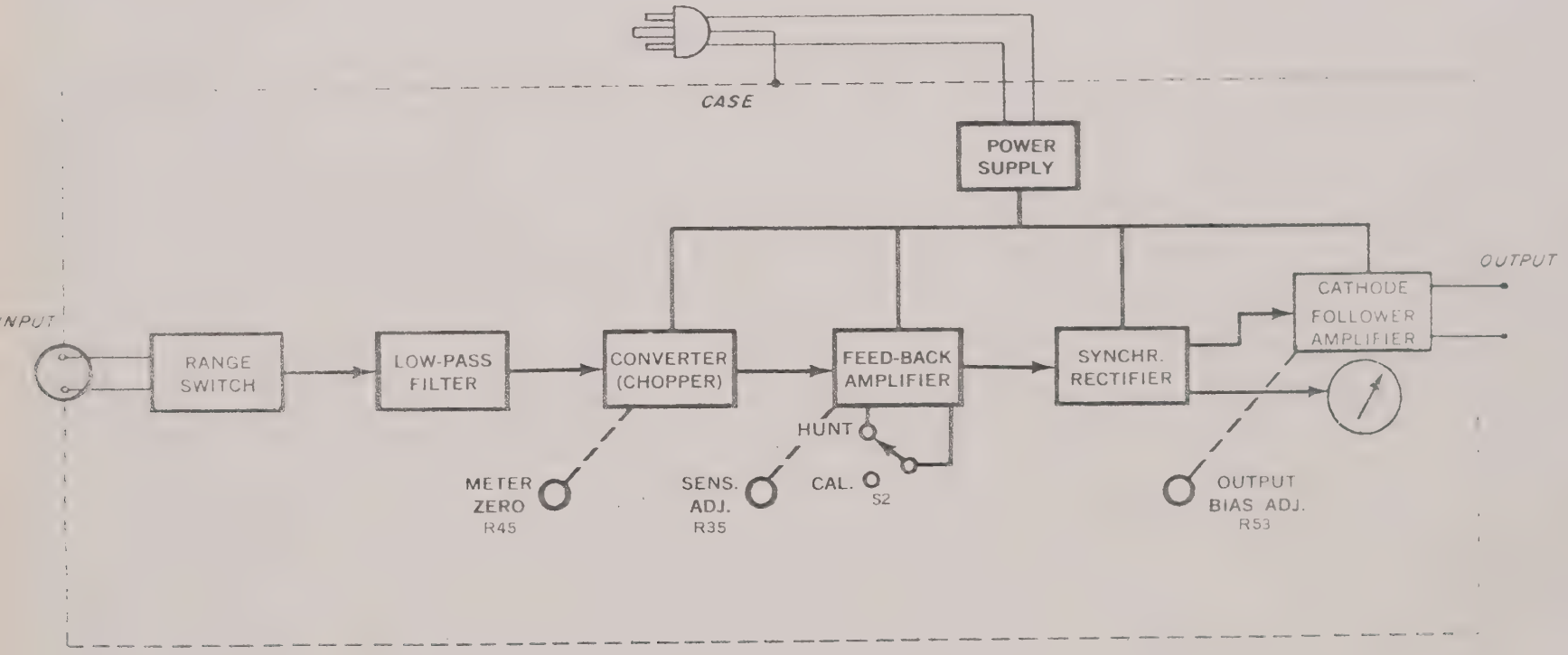


Fig. 2

Block Diagram --

Model 56A DC Null Detector

SECTION V

CALIBRATION & OPERATIONAL CHECKOUT PROCEDURE

5.1 Equipment needed

5.1.1 Megohmmeter: Freed type 1020B or equivalent

5.1.2 Variable Transformer: Superior Electric Powerstat Type 2PF10 (1A) or equivalent.

5.1.3 Resistance Bridge: Electro-Measurements Model 230R

5.1.4 DC Null Detector: Boonton ELECTRONICS Model 56A

5.1.5 VOM: Triplett Model 630A or equivalent

5.1.6 Ballantine AC Voltmeter Model 314 or equivalent

5.1.7 Recorder: Rustrak Model A or equivalent

5.1.8 Resistor: 2.2K 1/2W 5%

5.1.9 Resistor: 1K 1/2W 5%

5.1.10 DC Voltage source variable from 10 μv to 100 v ± 0.5%

5.2 Non-operating inspection

5.2.1 Meter zero adjustment. If the pointer is off zero, rotate the screw located in the center of meter case CCW or CW until the pointer rests at zero.

5.2.2 Remove the shorting link between ground and floating chassis posts and connect the megohmmeter across the posts. Normally the resistance measured should be about 1000 megohms. However; in the presence of high humidity it may measure as low as 200 megohms.

5.3 Amplifier calibration

5.3.1 Using the Powerstat set line voltage to 115 VAC and allow instrument to warm up for at least 15 minutes. Reconnect shorting link. Be sure to use the adapter plug attached to the end of the line cord with the ground wire unconnected. This will open any ground loops that may exist, which if they existed, might affect the accuracy when calibrating the instrument or making any low voltage measurements. It should

be noted that under normal operating conditions when the standard NEMA plug (three prong power plug) and receptacle are used, the grounded binding posts and black input cable clip are at power system ground potential.

5.3.1.1 With input cable removed and instrument turned on, set range to 1K. Measure the input impedance across #1 and #2 of input receptacle J2 using Resistance Bridge and DC Null Detector. If a reading of 10 megohms ± 1/2 % is not obtained the following adjustment must be made: Remove the two #8 screws on each side of the cabinet near the front panel. Remove the two #6 screws on the rear of the cabinet. The front panel and amplifier assembly can now be removed from the front of the cabinet. Remove the #4 screws securing the bottom plate to the amplifier and readjust the trimming capacitor C21 located at the base of the chopper socket XCH-1 with a non-metallic alignment tool. Before proceeding with the checkout it is recommended that a check be made for + 190 VDC ± 10% between Amplifier Chassis and Pin 1 of V4 and + 150 VDC ± 3% between Amplifier Chassis and Standoff E1 (R27). Replace bottom plate and Amplifier Assembly in cabinet, and secure screws.

5.3.1.2 Connect input cable to input receptacle and short the black and red clips together. Set range to 10K with Sens Adj. at maximum and HUNT/CAL in CAL. positio Vary meter zero control (R45) from full CCW to CW Meter should indicate approximately 50% of full scale on both sides of zero. Set range to 100K and reset to zero.

5.3.1.2.1. For accurate meter zeroing the input cable must be connected to the same source impedance, with no voltage present, that will exist for any particular range to be measured and the instrument set to the most sensitive range.

5.3.1.3 Set instrument to 100K range, set zero and apply 10 μv, either polarity, from DC voltage source to input cable. Adjust #1 control located on lower right side of cabinet for full scale deflection. Reverse polarity of test voltage and readjust #1 control if necessary to average the polarity reversing error if any exists. If an adjustment was necessary, meter zero must be rechecked and calibration repeated.

5.3.1.3.1 The voltages necessary to calibrate the instrument are as follows:

100K Range;	10 μv	10 Range;	100 mv
10K Range;	100 μv	1 Range;	1 v
1K Range;	1 mv	.1 Range;	10 v
100 Range	10 mv	.01 Range;	100 v

5.3.1.4 Repeat 5.3.1.3 procedure for 10K range, adjust #2 control.

5.3.1.5 Repeat 5.3.1.3 procedure for 1K range, adjust #3 control.

5.3.1.6 Check all ranges from 100 to .01 for full scale accuracy ± 3%. If the instrument is out of calibration on any range above 1K, repeat step 5.3.1.5 averaging out the error until all ranges from 1K to .01 are within the full scale accuracy of ± 3%. This completes the calibration of the instrument.

5.4 Operational Checkout-Instrument and Amplifier Output

5.4.1 Set range to 1K and set zero, apply dc voltage for full scale deflection, record positive and negative indication.

5.4.2 Reduce line voltage to 105 VAC and repeat 5.4.1.

5.4.3. Increase line voltage to 125 VAC and repeat 5.4.1. The change in readings between 5.4.1, 5.4.2, & 5.4.3 should not exceed 2% of 5.4.1. Reset line voltage to 115 VAC.

5.4.4. Range set to 1K with no voltage input, connect the 1K resistor in parallel with the VOM across the output terminals (plus terminal of the VOM to + output terminal). Vary Output Bias Adj. from full CCW to CW. The VOM should indicate less than zero with bias set CCW, and more than +1 VDC with bias set CW. Set Output Bias Adj. for zero output.

5.4.5 Apply +1 mv to input. Output voltage should be more than +1 v. Reverse polarity of input, output should be more than -1 v.

5.4.6 Decrease input voltage by 20% steps to zero input and increase in opposite polarity by 20% steps to 1 mv input. The instrument meter and output level non-linearity (tracking error) should be less than 2% of full scale.

5.4.7 With no voltage input, set Output Bias Adj. for 1 v output. Repeat 5.4.6, non-linearity should be less than 2%.

5.4.8 With no voltage input, set Output Bias Adj. for 0 v output, apply +1 mv input. Replace VOM with the Ballantine AC VTVM. The output ripple should be less than .01 v RMS.

5.4.9 60 db compression check. Remove Ballantine and adjust SENS. ADJ. control for a meter indication of 0.8. Switch HUNT/CAL control to HUNT and increase input voltage for the maximum meter indication. The input voltage should be 30 mv or more.

5.5 Amplifier drift and noise checkout

5.5.1 Drift and noise measurements must be made after the instrument has been off at least one hour. If the shorting link has been removed from the ground terminals it must be replaced at this time. Replace input cable with a "U" shaped shorting bus across pins 1 and 2 of input receptacle J1. SENS. ADJ. set at maximum and HUNT/CAL switch in CAL. position. Connect output terminal - to #2 of Rustrak Recorder, and output terminal + to #1 of recorder. (This sets the sensitivity of the recorder to equal the meter indication) Set range to 100K and zero meter. Switch to 1K range and adjust Output Bias Adj. control for a half scale reading on recorder. Switch back to 100K range and start recorder. The distance between the recorder and instrument under test should exceed 2 feet. The strong ac field from the recorder or any other source could cause indications which will affect the calibration & checkout of the instrument. After a 2 hour recording is completed, the recorded drift should be less than $\pm$ 2 μv after the first 1/2 hour. The noise (width of recorded output measured any time after the first 1/2 hour) should not be more than 1 μv peak to peak.

5.5.2 Zero offset check. With instrument set to 100K range and input open (cable removed, or probes unshorted) Record the zero offset after stablization. Position of zero control will have no affect on this reading. The indicated zero shift should be less than 0.5.

SECTION VI

TABLE OF REPLACEABLE PARTS

REFERENCE	DESCRIPTION			BEC PART NO.
C1	Capacitor, Mylar	0.1 µf	200v	230,116
C2	" "	0.022 µf	200v	230,101
C3	" "	0.022 µf	200v	230,101
C4	" "	0.1 µf	200v	230,116
C5	" Sil.M	1100 µµf 2%	500v	201,144
C6	" Mylar	0.022 µf	200v	230,101
C7	" Elec.	20 µf	475v	P/O 283,109
C8	" "	50 µf	6v	283,112
C9	" Mylar	0.005 µf	200v	230,121
C10	" "	0.005 µf	200v	230,121
C11	" Elec.	5 µf	6v	283,108
C12	" Mylar	0.005 µf	200v	230,121
C13	" "	0.005 µf	200v	230,121
C14	" "	0.1 µf	200v	230,116
C15	" "	0.1 µf	200v	230,116
C16	" Elec.	20 µf	25v	P/O 283,109
C17	" Mylar	0.1 µf	200v	230,116
C18	" "	0.1 µf	200v	230,116
C19	" Met.P	1.0 µf	200v	230,104
C20	" Elec.	50 µf	6v	283,112
C21	" Var.Mica	37-250 µµf	500v	275,118
C22	" Met.Pap.	0.05 µf	200v	230,117
C23	" Mylar	0.022 µf	200v	230,101
C24	Met.Pap.	0.05 µf	200v	230,117
C25	" Elec.	50 µf	50v	P/O 283,109
C26	Mylar	0.022 µf	600v	230,122
C27	" Elec.	20 µf	475v	P/O 283,113
C28	"	20 µf	475v	P/O 283,113
C29	"	20 µf	475v	P/O 283,113

REFERENCE		DESCRIPTION		BEC PART NO.
C34	Capacitor, Elect.	50 µf	25v	283,110
C35	" "	1000 µf	15v	P/O 283,114
C36	" "	1000 µf	15v	P/O 283,114
CH-1	Chopper	BBM - Special		540,108
CR-1	Rectifier	Sarkes - Tarzian #304B		532,001
D1	Diode	IN128		530,007
D2	"	IN128		530,007
D3	"	IN128		530,007
D4	"	IN128		530,007
D5	" Zener	14v 3/4W 10%		530,019
F1	Fuse	AGC 0.5 Amp.		545,502
I1	Lamp	GE 323	3v	545,106
I2	Lamp	GE 323	3v	545,106
L1	Choke	7 Hy Stancor #C1707		440,001
M1	Meter	100-0-100 µa Special		554,119
Q1	Transistor	2N34		[illegible]
R1	Resistor	8.92M 2W .5% *		[illegible]
R2		150K 1 2W 5%		301,139
R3		100K 1 2W 5%		301,135
R4		220K 1/2W 5%		301,143
R5		220K 1 2W 5%		301,143
R6		330K 1/2W 5%		301,147
R7		[illegible]		307,686

REFERENCE			DESCRIPTION				BEC PART NO.
R8	Resistor		1M	1/2W	1%	*	306,598
R9	"		90.9K	1/2W	1%	*	306,474
R10	"		9.09K	1/2W	1%	*	306,354
R11	"		909	1/2W	1%	*	306,234
R12	"		100	1/2W	1%	*	306,120
R13	"		2.2K	1/2W	5%		301,095
R14	"	Var.	1K	2W	20%	(1) Adj.	311,100
R15	"		3.9K	1/2W	5%		301,101
R16	"	Var.	2K	2W	20%	(2) Adj.	311,114
R17	"		47K	1/2W	5%		301,127
R18	"	Var.	25K	2W	20%	(3) Adj.	311,115
R19	"		6.8M	1/2W	5%		301,179
R20	"		1M	1/2W	1%	*	306,598
R21	"		1M	1/2W	5%		301,159
R22	"		1K	1/2W	5%		301,087
R23	"		47K	1/2W	5%		301,127
R24	"		2.2M	1/2W	5%		301,167
R25	"		1M	1/2W	5%		301,159
R26	"		10K	1/2W	5%		301,111
R27	"		47K	1/2W	5%		301,127
R28	"		2.2M	1/2W	5%		301,167
R29	"		470K	1/2W	5%		301,151
R30	"		1M	1/2W	5%		301,159
R31	"		1M	1/2W	1%	*	306,598
R32	"		2.2M	1/2W	5%		301,167
R33	"		100K	1/2W	5%		301,135
R34	"		2.2K	1/2W	5%		301,095
R35	"	Var.	1M	2W	20%	SENS. ADJ.	311,133
R36	"		470	1/2W	5%		301,079
R37	"		18K	1/2W	5%		301,117
R38	"		1M	1/2W	5%		301,159
R39	"		10	1/2W	5%		301,039

RESISTOR		DESCRIPTION				BEC PART NO.
R40	Resistor	100K	1/2W	5%		301,135
R41	"	1K	1/2W	5%		301,187
R42	"	1K	1/2W	5%		301,187
R43	"	10K	1/2W	5%		301,111
R44	"	18K	1/2W	5%		301,117
R45	" Var.	2K	2W	20%	Zero	311,153
R46		1M	1/2W	5%		301,159
R47	"	2.7K	1/2W	5%		301,097
R48	"	33K	1/2W	5%		301,123
R49	"	68K	1/2W	5%		301,131
R50	"	3.3K	1/2W	5%		301,099
R51	"	1M	1/2W	5%		301,159
R52	"	820K	1/2W	5%		301,157
R53	" Var.	25K	2W	20%	Bias Adj.	311,115
R54	"	15K	1/2W	5%		301,115
R55	"	4.7K	1/2W	5%		301,103
R56	"	150K	1/2W	5%		301,139
R57	"	56K	1/2W	5%		301,129
R59	"	120K	1/2W	10%		301,216
R60	"	220K	1/2W	5%		301,143
R61	" W.W.	7.5K	10W	10%		312,100
R62	"	3.9K	2W	5%		304,101
R63	"	120K	1/2W	10%		301,216
R64	"	12K	1/2W	10%		301,210
R65		1M	1W	20%		302,128

* Precision Resistors

S-1	Switch	3 Pole 12 Pos. CRL #PA2008	466,123
S-2		S.P. 2Pos. CRL #1460	466,124
S-3	"	S.P.S.T Carling #110-63	465,105

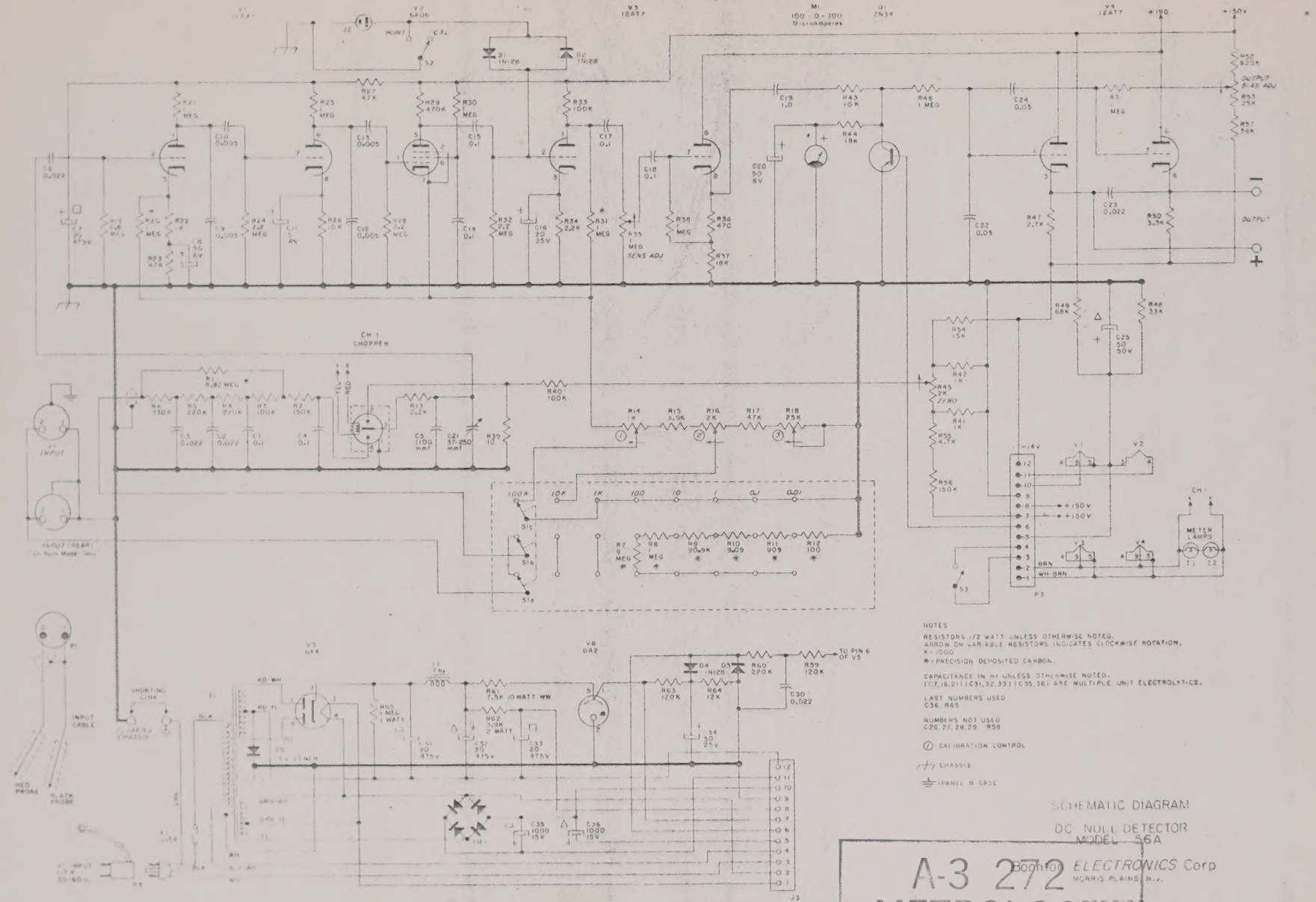
RESISTOR		DESCRIPTION	BEC PART NO.
T1	Transformer	Power Special	446,007
V1	Electron Tube	12AX7-Special	525,001
V2	"	6AU6	526,6AU6
V3	"	12AT7	526,12AT7
V4	"	12AT7-Special	525,002
V5	"	6X4	526,6X4
V6	"	OA2	526,OA2

WARRANTY

Boonton ELECTRONICS Corporation guarantees to the original purchaser that each instrument it manufactures be free from defects in material and workmanship for a period of one year after date of initial shipment. Our liability is limited to repairing or replacing any defective part with the exception of vacuum tubes, panel lamps, fuses, and batteries. The warranty lapses if, upon our examination, we judge that the instrument has been abused in any way.

PROCEDURE TO FOLLOW WHEN INSTRUMENT IS DEFECTIVE

1. Call our plant or our representative nearest you. A simple solution may result from discussion of the problem with our trained personnel.
2. If the fault is not readily eliminated, prepare the instrument for return to us. Pack carefully in a sturdy container using several inches of shock absorbing material on all six sides of the instrument. Include all probes, cables or accessory units. On all paper work pertaining to the returned instrument, note the model and serial number and state briefly the details of the fault. Ship to us transportation charges prepaid.
3. If the instrument is within the warranty, we will repair and return to you transportation charges prepaid. If the instrument is beyond the one year warranty period, we will repair and return it unless approval on a cost estimate is requested. If the instrument is within the one year warranty period, but our examination reveals abuse, we will await approval of our cost estimate before proceeding with repairs.



NOTES

RESISTORS 1/2 WATT UNLESS OTHERWISE NOTED.
ARROW ON VARIABLE RESISTORS INDICATES CLOCKWISE ROTATION.
K = 1000
* = PRECISION DEPOSITED CARBON.

CAPACITANCE IN mf UNLESS OTHERWISE NOTED.
(C7,16,21)(C31,32,33)(C35,36) ARE MULTIPLE UNIT ELECTROLYTICS.

LAST NUMBERS USED
C36, R65

NUMBERS NOT USED
C26,27,28,29 R58

(1) CALIBRATION CONTROL

CHASSIS

PANEL & CASE

SCHEMATIC DIAGRAM
DC NULL DETECTOR
MODEL 56A

Boonton ELECTRONICS Corp
MORRIS PLAINS, N.J.
230,0190

A-3 272
METROLOGY
LABORATORY

MP MASTER
MA24698